Binary Tomography Using Two Projections and Morphological Skeleton

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Binary Tomography (BT) [1] aims to reconstruct binary images from their projections. In the most common applications of BT usually just few projections of the object can be measured, since the acquisition of the projection data can be expensive or damage the object. Owing to the small number of projections the binary reconstruction can be extremely ambiguous. A common way to reduce the number of solutions of the reconstruction task is that certain geometrical properties (e.g., convexity and/or connectedness) are satisfied.

In this talk we investigate a new kind of prior information, the skeleton of the image to be reconstructed. Skeleton is a region-based shape descriptor which represents the general form of binary objects. One way of defining the skeleton of a 2-dimensional continuous object is as the set of the centers of all maximal inscribed (open) disks. The skeleton of a discrete binary image can be characterized via morphological operations [2], where disks are approximated by successive dilations of the selected structuring element that represents the unit disk. An interesting property of the morphological skeleton is that the original binary image can be exactly reconstructed from the skeletal subsets. In this work, we deal with the reconstruction problem in which the entire morphological skeleton (instead of the individual skeletal subsets) and two projections of the original image are known.

In the reconstruction process the prior knowledge is often incorporated into an energy function, thus the reconstruction task is equivalent to a function minimization problem. Many common methods exist to solve that kind of problems. In this talk, we show how to use Simulated Annealing (SA) [3] for the binary reconstruction problem using the information of the projections and the skeletal points. We show that, although theoretically the problem is non-unique, under some circumstances an acceptable image quality can be achieved. We propose three different methods to solve the above problem, based on parametric SA reconstruction.

This research was supported by the European Union and co-financed by the European Regional Development Fund within the project TÁMOP-4.2.1/B-09/1/KONV-2010-0005. The work of the second author was also supported by the János Bolyai Research Scholarship of the Hungarian Academy of Sciences and by the OTKA PD100950 project of the National Scientic Research Fund.

References

[1] Herman, G.T., Kuba, A. (eds.): Advances in Discrete Tomography and Its Applications. Birkhäuser, Boston (2007)

[2] Gonzalez, R.C., Woods, R.E.: Digital Image Processing (3rd Edition). Prentice Hall (2008)

[3] Kirkpatrick, S., Gelatt Jr., C.D., Vecchi, M.P.: Optimization by Simulated Annealing. Science 220, 671–680 (1983)